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A new species of *Rhinophis* Hemprich, 1820 (Squamata, Uropeltidae) from Siruvani Hills, Western Ghats, India

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Abstract

We describe a new species of uropeltid snake of the genus *Rhinophis* based on a series of three specimens collected from the Siruvani Hills, which is part of the Central Western Ghats in Kerala and Tamil Nadu states of Peninsular India. *Rhinophis siruvaniensis* **sp. nov.** is diagnosed from other Indian and Sri Lankan congeners by a combination of 17 dorsal scale rows at (or well beyond) mid-body, 202–205 ventral scales, 4–8 paired subcaudals, and dark brownish-black dorsal and pale whitish blotched lateral and ventral colouration. Phylogenetic reconstructions using mitochondrial markers indicate that the new species is most closely related to *R. melanoleucus*, but the two species can be distinguished by their unique external morphology and geographic separation. The discovery of this species from outside protected areas in the Attappadi Plateau highlights the need for improved protection of the remaining forests in the Siruvani Hills.

Key Words

Burrowing, fossorial, morphology, Palghat Gap, shieldtail snakes, scalation, Wayanad

Introduction

The family Uropeltidae (commonly called shieldtail snakes) are a group of small-sized snakes adapted to a fossorial lifestyle (Pyron et al. 2016). Currently, there are 73 known species of uropeltid snakes (Uetz et al. 2025) classified under seven genera and distributed across Peninsular India and Sri Lanka (Cyriac and Kodandaramaiah 2017). However, recent phylogenetic studies have suggested high levels of cryptic diversity within these snakes (Sampaio et al. 2023; Cyriac et al. 2024), calling for fine-scale sampling, especially in regions of high uropeltid diversity, such as the Western Ghats of India (Cyriac et al. 2024).

Rhinophis Hemprich, 1820 with 26 species is the second most-diverse genus within Uropeltidae and the only one that occurs both in Peninsular India and Sri Lanka (Pyron et al. 2016; Cyriac and Kodandaramaiah 2017; Sampaio et al. 2023). Although most *Rhinophis* diversity is present in Sri Lanka (20 species), this genus is represented by six species in Peninsular India, viz, *R. sanguineus* Beddome, 1863, *R. travancoricus* Boulenger, 1893, *R. fergusonianus* Boulenger, 1896 and the recently described *R. goweri* Aengals & Ganesh, 2013, *R. melanoleucus* Cyriac, Narayanan, Sampaio, Umesh & Gower, 2020 and *R. karinthandani* Sampaio, Narayanan, Cyriac, Venu & Gower, 2020 (Aengals and Ganesh 2013; Cyriac et al. 2020; Sampaio et al. 2020). *Rhinophis travancoricus* and *R. fergusonianus* are known from the Southern Western Ghats, *R. goweri* is found in the Southern Eastern Ghats (Aengals and Ganesh 2013; Ganesh and Arumugam 2016; Pyron et al. 2016; Gower et al. 2023) and the remaining species have been recorded in the Waynad-Malnad Hills from north of Nilgiris to Mookambika Hills in the north (Cyriac et al. 2020; Sampaio et al. 2020). During our field surveys for uropeltid snakes, we encountered a novel

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Rhinophis population in the Attappadi Plateau of Siruvani Hills. In this work we name and describe this population as a new species based on its phylogenetic placement, a suite of unique external morphological characters and its geographic separation from other closely related species.

Materials and methods

Morphological data

Specimens were hand collected from plantations where they were dug out during agricultural digging operations. They were then euthanized when necessary, fixed in 4% formaldehyde for about two hours, washed in water and preserved in 70% ethanol. Liver tissue from one specimen was taken for genetic analysis and stored in absolute alcohol prior to formalin fixing. The specimens were deposited at the Bombay Natural History Society (**BNHS**), Mumbai and the Centre for Ecological Science (**CES**), Indian Institute of Science, Bengaluru. External morphological characters including scalation, measurements and colour patterns were documented using a Leica Stereo microscope. We followed Cyriac et al. (2020) to record a total of 31 morphometric and meristic characters. The list of characters and their abbreviations are provided in Table 1. Ventral scale counts were recorded following Gower and Ablett (2006), and dorsal scale row reductions followed Dowling (1951). Additionally, dorsal scale rows are reported from the anterior region, about one head-length behind the head, at mid-body, and about one head-length before the vent. Measurements were taken using a Yuri Silver digital vernier caliper to the nearest 0.1 mm. Snout-vent length was measured by subtracting the tail length from the total length, which was measured to the nearest 1 mm using a measuring tape. Individuals were considered as adults or juveniles based on their overall sizes, which were comparable to those reported for other Indian *Rhinophis* species. Comparative data for other Indian and Sri Lankan *Rhinophis* were obtained either from published literature (Pyron et al. 2016; Wickramasinghe et al. 2017, 2020; Cyriac et al. 2020; Gower 2020; Sampaio et al. 2020; Gower et al. 2024) or by examining specimens deposited at CES, BNHS or ZSI-SRC (Zoological Survey of India-Southern Regional Centre, Chennai) (Suppl. material 1). Specimens having voucher numbers under the VP series are currently deposited at the museum in CES.

Table 1. Morphometric (in mm) and meristic data of the three types and one referred specimen of *Rhinophis siruvaniensis* sp. nov. Scale counts on the left and right side are separated by a slash (/). The hyphen (-) indicates unrecorded data.

	Definition	Holotype BNHS 3387	Paratype BNHS 3388	Paratype VPRS0622157	Other material VPRS0720116
SuL	Supralabials	4/4	4/4	4/4	4/4
InL	Infralabials	3/3	3/3	3/3	3/3
DS	Dorsal scale rows	19:17:15	19:17:15	19:17:15	
VS	Ventral scales	205	202	205	203
SC	Subcaudal scales	8/8	4/5	6/6	8/8
SVL	Snout-vent length	284.2	203	240.6	106.1
TL	Tail length	9.8	4	5.4	3.9
AW	Anterior width (measured ca. 20 mm behind the head)	6.3	5.2	7.1	-
MW	Mid-body width	6.7	5	5.1	-
VW	Width at vent	5.9	4.1	5.3	-
HL	Head length	6.9	6	6.4	-
HW	Head width	3.7	3.3	3.5	-
RL	Rostral length	2.7	2.6	2.6	-
ED	Eye diameter	0.5	0.5	0.5	-
OL	Ocular length	1.7	1.5	1.5	-
IED	Inter-eye distance	2.2	2.1	2	-
IND	Inter-nostril distance	1.3	1.1	1.1	-
SL	Snout length	3.2	2.9	2.9	-
FL	Frontal length	2.3	1.7	1.6	-
FW	Frontal width	1.9	1.8	1.7	-
PL	Parietal length	2.2	1.7	1.8	-
PW	Parietal width	1.8	1.7	1.6	-
IPC	Midline contact between parietals	0.5	0.5	0.7	-
PFL	Prefrontal length	1.2	1	1.1	-
PFW	Prefrontal width	1.4	1.5	1.4	-
IPFC	Midline contact between prefrontals	0.4	0.4	0.4	-
NL	Nasal length	1.4	1.2	1.2	-
NW	Nasal width	1.4	1.4	1.2	-
TDL	Tail disc length	7.8	6	6.7	-
TDW	Tail disc width	6.3	4.9	5.7	-
TDB	Tail disc breadth	4.6	4.5	4.7	-

Phylogenetic reconstruction

We extracted total genomic DNA from the liver tissue of one *Rhinophis* specimen using the high salt extraction process following standard protocols (Miller et al. 1988). We then amplified two mitochondrial markers (16S rRNA and NADH dehydrogenase subunit 4: ND4) using a standard 3-step PCR protocol (Palumbi et al. 1991). The primers and the PCR protocols used for amplification are described in Cyriac and Kodandaramaiah (2017) and Sampaio et al. (2023). We checked the PCR products using gel electrophoresis and Sanger sequenced the amplicons using the forward and reverse primer tails. Sequencing was conducted at Barcode Bioscience, Bangalore.

The forward and reverse sequences were checked manually and a consensus sequence was generated. The newly generated sequences for the voucher VPRS 0622157 was uploaded on GenBank under the accession numbers PX069028 (16s rRNA) and PX068205 (ND4). These sequences were then plugged into an assembled 16S rRNA and ND4 sequence matrix for *Rhinophis* from Sampaio et al. (2020, 2023). Since relationships within *Rhinophis* are generally not well resolved (Cyriac and Kodandaramaiah 2017; Sampaio et al. 2023), we included an additional mitochondrial marker (12S rRNA) to the sequence matrix. We also included sequences of *Plectrurus* and *Pseudoplectrurus* as outgroups from GenBank for the three markers (Suppl. material 2). We aligned each sequence matrix using the default settings in the MUSCLE algorithm (Edgar 2004) implemented in MEGA11 (Tamura et al. 2021) and manually checked the alignments for errors. For the two non-protein coding markers (16S rRNA and 12S rRNA), we removed ambiguously aligned sites using Gblocks v.0.91b under default settings (Talavera and Castresana 2007) implemented in Phylosuit v 1.2.2 (Zhang et al. 2020). The three mitochondrial markers were concatenated and used for further phylogenetic reconstructions.

The non-protein coding 16S rRNA and 12S rRNA markers were partitioned by gene while the protein-coding ND4 marker was partitioned by codon position, after which we carried out phylogenetic reconstructions using Maximum Likelihood (**ML**) and Bayesian Inference (BI). The ML analysis was carried out in the IQ-TREE v 2.0.6 web server (Minh et al. 2020) using the GTR+I+G+F nucleotide substitution model, identified using the in-built auto function. We also implemented 1000 ultrafast bootstrap (**UFB**) replicates to assess branch support. We performed BI in MrBayes v.3.2.7 (Ronquist et al. 2012) incorporating the best-fit partition scheme and nucleotide substitution model using PartitionFinder2 v.2.1.1 (Lanfear et al. 2017). The best-fit substitution model implemented a GTR+I+G model for the 16S rRNA and 12S rRNA, and TIM+G, TRN+G and HKY+I+G for the three ND4 codon positions. The BI analysis implemented two independent runs of five million generations sampling every 500 generations. We checked the two runs for convergence by examining the trace plots in Tracer v.1.7.1 (Rambaut et al. 2018) and ensuring the Effective Sample Size (**ESS**) values were greater than 200 and the Potential Scale Reduction Factor was close to 1. The first 25% of the trees were discarded as burn-in and the remaining trees were summarized as a maximum clade credibility (**MCC**) tree with posterior probabilities (**PP**) used to quantify branch support. The resulting trees were rooted with the *Plectrurus* + *Pseudoplectrurus* clade based on previous phylogenetic analyses (Cyriac and Kodandaramaiah 2017; Sampaio et al. 2023).

Results

The phylogenetic analyses (Fig. 1) indicated that most Peninsular Indian *Rhinophis* (except *R. travancoricus* and *R. goweri*) formed a well-supported clade (UFB = 99; PP = 1). Within this clade, there was strong support for a sister relationship between *R. sanguineus* from Wayanad and two *Rhinophis* sp. from Karnataka (UFB = 100; PP = 1), which together were sister to *R. karinthandani* (UFB = 100; PP = 1). *Rhinophis fergusonianus* formed a strong sister relationship with the clade comprising *R. sanguineus*, *Rhinophis* sp. and *R. karinthandani* (UFB = 99; PP = 1), and this clade was sister to *R. melanoleucus* and the newly sampled *Rhinophis* from Attappadi, Palakkad (UFB = 99; PP = 1). The specimen from Attappadi, Palakkad formed a strong sister relationship with the two specimens of *R. melanoleucus* from Wayanad (UFB = 100; PP = 1). Both ML and BI trees indicated that *R. travancoricus* and *R. goweri* were more closely related to the Sri Lankan *Rhinophis* with strong support (UFB = 99; PP = 1). However, there was no clarity in the position of *R. goweri*, with a strongly supported sister relationship with the Sri Lankan *Rhinophis* in the ML analysis (UFB = 96) but remained unresolved in the BI analysis. Comparing the uncorrected p-distances indicated moderate levels of divergence between the Attappadi sample and *R. melanoleucus* (16S rRNA: n = 2, range = 2.0–2.2%; ND4: n = 2, 4.0–4.1%). Additionally, we found morphological differences between these two lineages in key taxonomic characters such as the number of ventral scales and dorsal scale row changes (Table 1, Suppl. material 3). Based on genetic divergence, morphological differences and its geographic distribution in Siruvani Hills of the Attappadi Plateau, we describe the Attappadi population as a new species below.

Taxonomy

Family Uropeltidae Müller, 1832
Genus *Rhinophis* Hemprich, 1820

***Rhinophis siruvaniensis* sp. nov.**

https://zoobank.org/E4E3FB10-D0B8-4B14-AB59-E6772A20680A

Table 1, Figs 2–4

Type material. ***Holotype*:** India • adult; India, Kerala, Palakkad District, Attappadi, Jellipara; 11.056783°N, 76.607611°E; 781 m a.s.l; 10 July 2015; by Vivek Philip Cyriac, Umesh P.K. & Basil P. Das leg.; BNHS 3387.

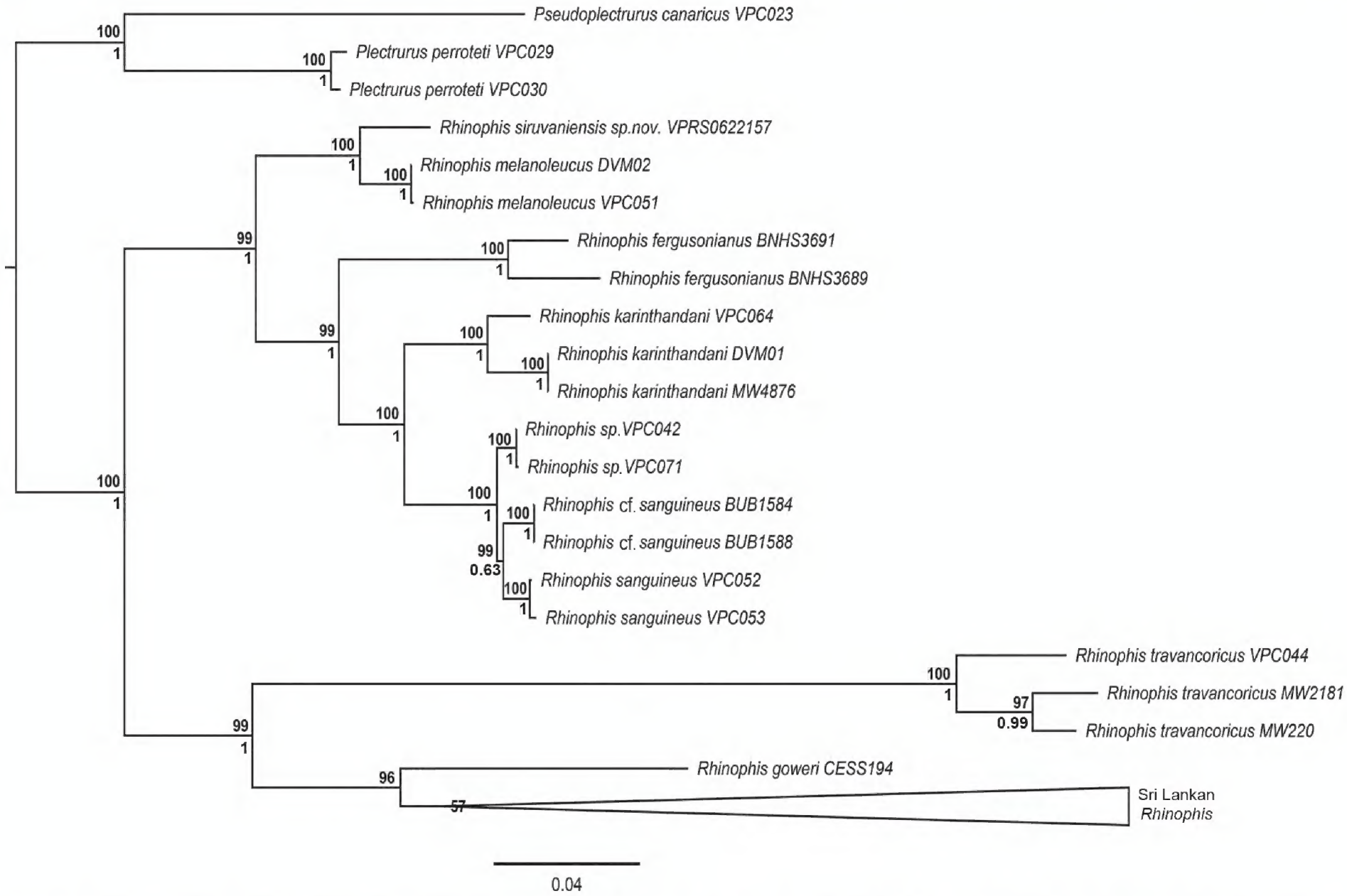

Figure 1. Phylogenetic relationships among Indian *Rhinophis*, based on mitochondrial DNA sequence data. The values at the nodes are branch support with Bayesian posterior probabilities on the bottom and ultrafast bootstrap values on the top of the branch.

Figure 2. Dorsal and ventral views of the holotype (BNHS 3387) of *Rhinophis siruvaniensis* sp. nov. Photographs by VPC.

***Paratypes*:** India • 2 adults; India, Tamil Nadu, Coimbatore District, Siruvani Hills, enroute to Sholayur, near Kolikuddam village; 11.043298°N, 76.691499°E; 1000 m a.s.l.; May 2020; N. S. Achyuthan, Nitin Xavier-leg.; VPRS 0622157, BNHS 3388.

Other material. India • 1 juvenile; slightly dehydrated specimen; same data as holotype; VPRS0720116.

Diagnosis. A species of *Rhinophis*, characterized by the following combination of characters: 19 dorsal scale rows in the anterior region, 17 at mid-body and 15 near the vent; ventrals 202–205; subcaudals 4–8 pairs; large, dome-shaped tail shield covering the width of the tail; dorsum dark brownish black, lustrous; venter creamy white, this pattern projecting ventrolaterally as intermittent

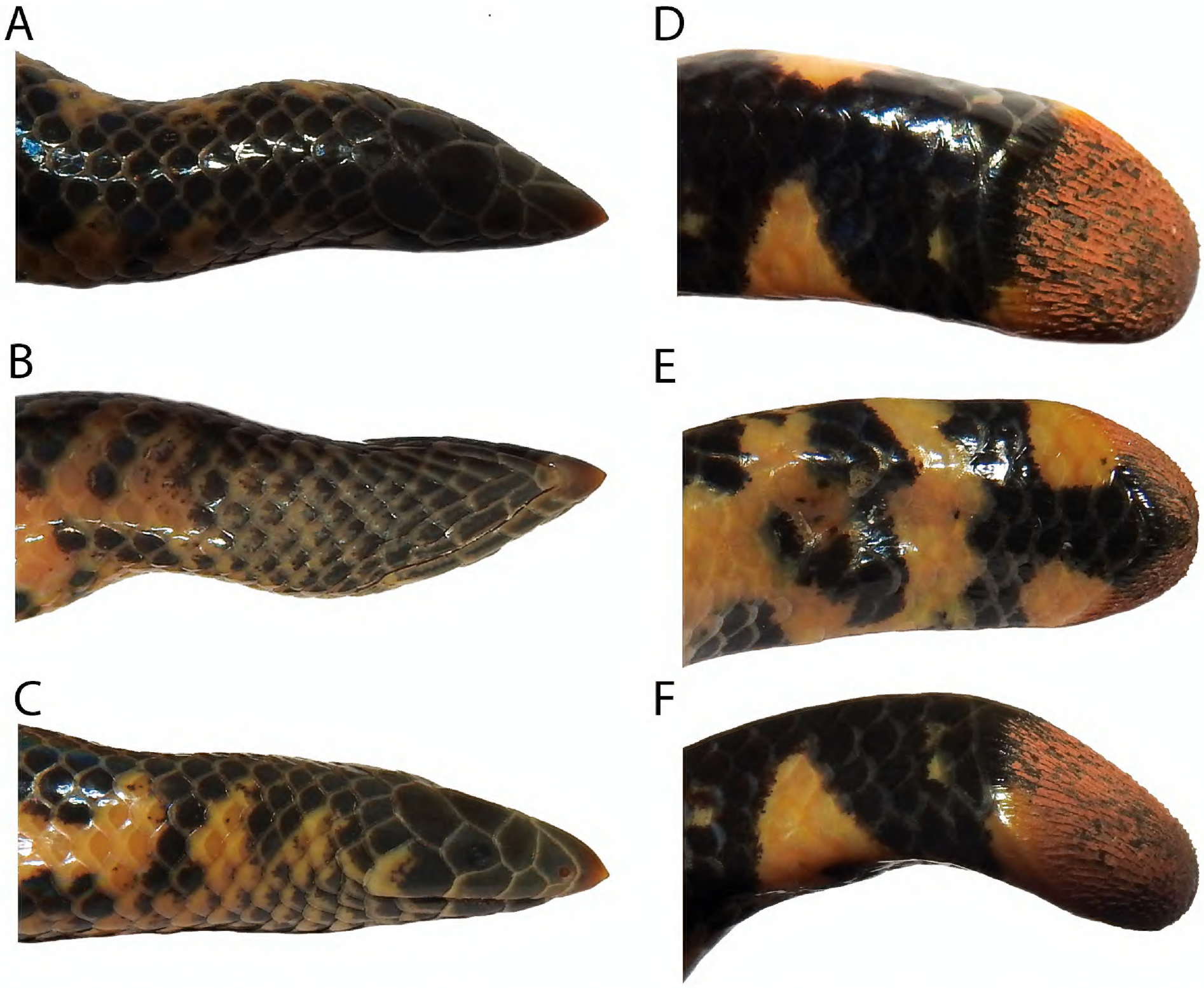

Figure 3. Head (left) and tail (right) of the holotype (BNHS 3387) of *Rhinophis siruvaniensis* sp. nov., shown in dorsal (**A, D**), ventral (**B, E**) and lateral (**C, F**) views. Images are not to scale. Photographs by VPC.

patches; venter and ventrolateral region with large, bold, brownish black blotches occupying 2–5 ventral scales, interspersed with creamy white colour.

Comparisons with congeners. *Rhinophis siruvaniensis* sp. nov. can be distinguished from all other Peninsular Indian *Rhinophis* except *R. travancoricus* and *R. goweri* by the presence of 17 dorsal scale rows at mid-body (versus 15 mid-body dorsal scale rows in *R. sanguineus*, *R. fergusonianus*, *R. melanoleucus* and *R. karinthandani*). It differs from the former two species in having more ventral scales; 202–205 versus < 160 in *R. travancoricus* and < 201 in *R. goweri*. The new species also has more ventrals than *R. fergusonianus* (> 201 versus 183–197). *Rhinophis siruvaniensis* sp. nov. differs from *R. goweri*, *R. karinthandani* and *R. sanguineus* in its ventral colouration in having a creamy white venter extending ventrolaterally as intermittent patches along with dark brownish black blotches (versus bright yellow venter heavily speckled with brown in *R. goweri*; ventral region off white and heavily speckled with black markings along with an off-white ventrolateral line in *R. karinthandani*; and a bright red venter in *R. sanguineus*). *Rhinophis siruvaniensis* sp. nov. closely resembles its sister species *R. melanoleucus* in overall colouration, but can be easily differentiated by having fewer ventral scales (< 206 versus > 217) and in having 17 dorsal scale rows at mid-body (and slightly beyond) (versus 15 dorsal scales at mid-body in *R. melanoleucus*).

In addition to biogeographic and molecular phylogenetic distinctiveness, the new species can be distinguished morphologically from all 20 currently recognized Sri Lankan congeneric species as follows: *Rhinophis siruvaniensis* sp. nov. differs from *R. saffragamus* (Kelaart, 1853) in having a domed tail shield, lacking midline contact between the nasals, and having 17 mid-body dorsal scale rows (versus a flat, disc-like tail shield; midline contact between nasals; and 19 mid-body dorsal scale rows).

The new species can also be differentiated by its higher ventral count (202–205) from *R. blythii* Kelaart, 1853 (148–168 ventrals), *R. drummondhayi* Wall, 1921 (173–191), *R. erangaviraji* Wickramasinghe, Vidanapathirana, Wickramasinghe & Ranwella, 2009 (142–154), *R. gunasekarai* Wickramasinghe, Vidanapathirana, Wickramasinghe & Gower, 2020 (177–182); *R. lineatus* Gower & Maduwage, 2011 (183–195), *R. martin* Gower, Sampaio,

Figure 4. *Rhinophis siruvaniensis* sp. nov. in life. Paratype VPRS0622157 showing adult colouration (**A**) (Photograph by Nitin Xavier) and referred specimen VPRS0720116 showing juvenile colouration (**B**) (Photograph by UPK).

Vidanapathirana & Wickramasinghe, 2024 (167–186), *R. melanogaster* (Gray, 1858) (152–166), *R. mendisi* Gower, 2020 (159–177), *R. philippinus* (Cuvier, 1829) (154–179), *R. roshanpererai* Wickramasinghe, Vidanapathirana, Rajeev & Gower, 2017 (168–169), and *R. tricoloratus* Deraniyagala, 1975) (163). *Rhinophis siruvaniensis* sp. nov. has fewer ventrals (< 210) than *R. dorsimaculatus* Deraniyagala, 1941 (227–250 ventrals), *R. oxyrhynchus* (Schneider, 1801) (211–227), *R. porrectus* Wall, 1921 (281) and *R. punctatus* Müller, 1832 (236–246).

The new species differs additionally from *R. blythii*, *R. gunasekarai*, *R. lineatus*, *R. martin*, *R. melanogaster*, *R. mendisi*, *R. phillipsi* (Nicholls, 1929), *R. roshanpererai* and *R. zigzag* Gower & Maduwage, 2011 in having a large domed tail shield that is almost as wide as the tail (versus a smaller, conical or dome-shaped tail shield notably narrower than the tail).

Rhinophis siruvaniensis sp. nov. shares a broadly overlapping ventral count and a large domed tail shield with *R. homolepis* Hemprich, 1820 and *R. dinarzardae* Gower, Sampaio, Vidanapathirana & Wickramasinghe, 2024, but can be readily differentiated from these two species by its brownish-black dorsum, creamy white venter with black blotches and the lack of a pale white ring around the tail (versus a pale white ring around the base of the tail in *R. homolepis* and a uniform brown-grey dorsum and punctate venter in *R. dinarzardae*).

Description of holotype. Adult specimen, well-preserved, with a ventral incision for extracting tissue sample. Head small (HL 2.4% of SVL) with a pointed snout. Rostral pointed, having a narrow, rounded dorsal ridge but no dorsal crest; much longer than wide; and approximately 6.8 times longer (in dorsal view) than rostral-frontal gap. Rostral contacts the nasals and prefrontals, but does not contact the mental when the mouth is closed. Nasals not in contact, separated by the posterior half of the rostral, pierced by the small, subcircular, slightly sunken external naris at the anteroventral corner. Nasals in contact with the rostral, and the first and second supralabials ventrally. Prefrontals wider than long, in contact with each other along the midline but slightly separated anteriorly by the rostral and in contact with the 2nd and 3rd supralabials. Prefrontals shorter than the frontal, being slightly longer than half the frontal length. Frontal subhexagonal, longer than wide, but shorter than the rostral; anterolateral margins truncated, lateral (ocular) margins shortest, slightly converging towards each other posteriorly; posterolateral edges longest, meeting each other approximately at a right angle. Frontal in broad contact with parietals, less so with ocular shields, subequal to parietal length. Paired parietals, longer than broad, sub-hexagonal; in narrow contact with each other (IPS 22.7% of PL), slightly longer than prefrontal length, and separated more by frontal than remaining median interparietal contact. Eye distinct, small, bulging only slightly from ocular surface, its diameter approximately 29.4% the length of the ocular, located near anteroventral corner of ocular. Four supralabials on each side; the first smallest, rhomboidal, contacting rostral, nasal and 2nd supralabial; the 2nd supralabial taller than first and as tall as third; 3rd supralabial longer than tall; 4th supralabial largest, larger than parietals and much taller than the rest. The 3rd and 4th supralabials occupy more than half the head length and contact the ocular scale. Mental small, sub-pentagonal, much broader than long, smaller than infralabials, and separated from the ventrals and the postmentals by the first pair of infralabials. Three rectangular infralabials on each side; much longer than tall; 2nd infralabial largest, twice as long as the first; 3rd infralabial larger than the first and tapering posteriorly.

Body elongated and cylindrical. Dorsal body scales macroscopically smooth, sub-hexagonal, mostly evenly sized. Ventrals 205, much wider than long and evenly sized except for the anteriormost 8 scales which are narrower. Dorsal scale rows 19 anteriorly, reducing to 17 by the 44th ventral and to 15 rows by 146th ventral until close to the vent. Dorsal scale row reduction formula:

$$19\frac{3+4(51)}{4+5(44)}17\frac{3+4(146)}{-4(142)}15$$

Anal scales paired, right overlapping the left, much larger than posteriormost ventrals and subcaudals. Subcaudals paired, eight on each side, smooth and longer than adjoining outer rows of scales. Some scales adjoining the subcaudals bear low, short parallel ridges or keels towards posterior edges. Tip of the tail forming a large caudal

disc or 'shield' covering ca. 80% of the tail length; upper surface slightly concave anteriorly, domed posteriorly, longer than wide (TDW 80.7% of TDL), about 1.3 times wider than the tail depth (at base of shield) and longer than head length. Base of the tail shield surrounded by 15 scales (including the last subcaudals). Tail shield rugose, with several narrow, evenly spaced, broken ridges, somewhat tapering towards the tip.

Colouration in life. Dorsum dark brownish black, lustrous; venter creamy white, intermittently projecting ventrolaterally as irregular patches; this pattern is interrupted by a consecutive series of large, bold, brownish black blotches stretching 2–5 ventral scales and covering 3–5 adjacent dorsal scales. Subcaudals medially brownish black, flanked on both sides laterally with orange that extends into the tail shield. Tail disc medially brownish black with a creamy orange patch on the lateral side.

Colouration in preservation. After 2 years in ethanol, overall resembling that in life, except for ventral yellow and subcaudal orange fading to dirty white; iris ashy grey.

Variation (n=3). Variation across different meristic and morphometric characters are reported in Table 1. The paratypes and the referred specimens largely agree with the holotype in overall morphology and colouration except for the frontal length being subequal to frontal width, and parietal length being subequal to parietal width in BNHS 3388 and VPRS0622157. Additionally, in paratype BNHS 3388, the nasals are wider than long. Dorsal scale rows reduce from 19 to 17 by the 50th ventral and to 15 rows by the 172nd ventral in VPRS0622157, and from 19 to 17 by the 35th ventral and to 15 rows by the 131st ventral in BNHS 3388. The number of scales surrounding the tail shield (including the distal subcaudals) range from 14–17. The ventral scales range from 202–205 and subcaudals range from 4–8 with paratype BNHS 3388 having four and five subcaudals on the right and left side respectively. The referred specimen VPRS0720116, which is presumably a neonate, had eight subcaudals on each side but with the 2nd, 7th and 8th subcaudals being undivided.

Etymology. Toponym, latinised after its known distribution range – the Siruvani Hills.

Distribution and natural history. *Rhinophis siruvaniensis* sp. nov. is currently known only from around the type locality. There is a need for further surveys in Attappadi and the wetter regions of the adjacent Anaikatti Hills to more comprehensively document the distribution range of *R. siruvaniensis* sp. nov. The region is characterized by mid-elevation (800–1100 m asl) wet evergreen forests found amidst villages and spice plantations. The type specimens were discovered within cardamom and coffee plantations. Live specimens were typically found under fallen logs and rocks or during minor digging operations inside plantations at a depth of about 30 cm. Local farmers also reported that these snakes are sometimes inadvertently wounded or killed while digging during their usual course of routine work. Roadkills as well as live snake crossings were also sighted in the tarred road connecting Anaikatti and Attappadi that traverses the hills where the type locality lies.

Most of the observed specimens presumably represent adults, except for VPRS0720116, which was considerably smaller (110 mm total length). This smaller specimen was excavated from the soil in a small plantation at Jellipara, Attappadi, in July 2020. Wall (1919) noted umbilical scars in several small specimens of *R. sanguineus* found between July and August, and reported that juveniles typically range from 120 to 140 mm in total length. The specimen referred to as VPRS0720116 was smaller than the juvenile size range indicated by Wall (1919), suggesting that it is a neonate or juvenile. The presence of juveniles in July suggests that the breeding season is likely associated with the southwest monsoons (June–July). Based on anecdotal details from experienced local farmers, *R. siruvaniensis* sp. nov. is presumed to be active on land surface during night or day and feed on earthworms and are generally observed during June–December, coinciding with the southwest and the northeast monsoons. Other potentially sympatric uropeltids recorded around the type locality include *Uropeltis* cf. *brevis*, *U.* cf. *nilgherriensis*, *U. ocellata* (Beddome, 1863) and another recently described species, *Teretrurus siruvaniensis* Cyriac, Ganesh, Madani, Ghosh, Kulkarni & Shanker, 2024 (see Cyraic et al. 2024).

Revised key to the Indian species of *Rhinophis*

We update the key to Indian *Rhinophis* by Gower et al. (2023), with the inclusion of this new species.

1	Number of dorsal scale rows slightly behind mid-body 17	2
–	Number of dorsal scale rows slightly behind mid-body 15	4
2	Ventral scales fewer than 160	*R. travancoricus*
–	Ventral scales more than 180	3
3	Ventral colouration uniform or punctate	*R. goweri*
–	Ventral colouration off white with large black blotches	*R. siruvaniensis* sp. nov.
4	Ventral scales > 215	*R. melanoleucus*
–	Ventral scales < 215	5
5	Ventral surface with dark irregular blotches or transverse half-bands (or an irregular midline zigzag)	*R. fergusonianus*
–	Ventral surface with irregular dark speckles or spots	6
6	Ventral colouration bright red in life (paler or orange-yellow in smaller specimens)	*R. sanguineus*
–	Ventral colouration whitish with dark markings	*R. karinthandani*

Discussion

The genus *Rhinophis* is relatively well documented in Sri Lanka but the congeners have not been sampled extensively across Peninsular India. *Rhinophis siruvaniensis* sp. nov. is the fourth new species of *Rhinophis* to be described from India in the last two decades, after *R. goweri* (see Aengals and Ganesh 2013), *R. melanoleucus* (see Cyriac et al. 2020) and *R. karinthandani* (see Sampaio et al. 2020). In addition to these new discoveries, recent efforts have also 'rediscovered' *R. fergusonianus* which was not reported for over a century (Gower et al. 2023).

Although we find only moderate levels of genetic divergence in the mitochondrial markers (2–2.2% on 16s rRNA and 3.9–4.1% on ND4) between the new species and its sister lineage (*R. melanoleucus*), they have distinct morphologies. While we use only mitochondrial data for our phylogenetic inference, which can obscure the true evolutionary history of the lineage (e.g. Chan et al. 2020; Harrington and Burbrink 2023; Yuan et al. 2023), we use the clades derived from the analysis as testable species hypotheses that can be verified through other lines of data (Puillandre et al. 2012; Wüster et al. 2024). Even though both lineages have similar colouration, they differ considerably in the number of ventral scales and the number of dorsal scale rows at mid-body, both important morphological characters that have been used extensively to delimit/describe other uropeltid species (e.g. Cyriac et al. 2020, 2024; Sampaio et al. 2020; Gower et al. 2023). Additionally, the two lineages are geographically separated with *R. melanoleucus* restricted to the south-western region of the Wayanad plateau and *R. siruvaniensis* sp. nov. found in the Attappadi plateau and Siruvani Hills. These two regions are interrupted by several valleys and massifs including the Chaliyar River, a deep river valley separating the Camel's Hump Hills and the Gudalur Plateau and the high massifs of the Nilgiri Hills (Fig. 5). These massifs, separated by the Chaliyar River Valley, have been shown to be a biogeographic barrier for many mid to high-elevation species (Robin et al. 2010; Vijayakumar et al. 2016), and may have acted as a barrier to gene flow between *R. siruvaniensis* sp. nov. and *R. melanoleucus*. The moderate genetic divergence, the considerable morphological differences and the distribution across multiple geographic barriers together provide substantial evidence for the two populations being distinct species. Nonetheless, future analyses using nuclear genomic data might reveal deeper insights into potential gene flow, speciation and clarify phylogenetic relationships within the group.

Morphologically, *R. siruvaniensis* sp. nov. is superficially similar to *R. goweri*, the two sharing 17 mid-dorsal scale rows and having overlapping reported ventral scale counts. Although the original description of *R. goweri* reported 215 ventral scales (Aengals and Ganesh 2013), a subsequent study reported 189–192 ventral scales based on five unvouchered individuals (Ganesh and Arumugam 2016). However, reexamining the sole type specimen of this species in this study revealed only 200 ventral scales. We also examined

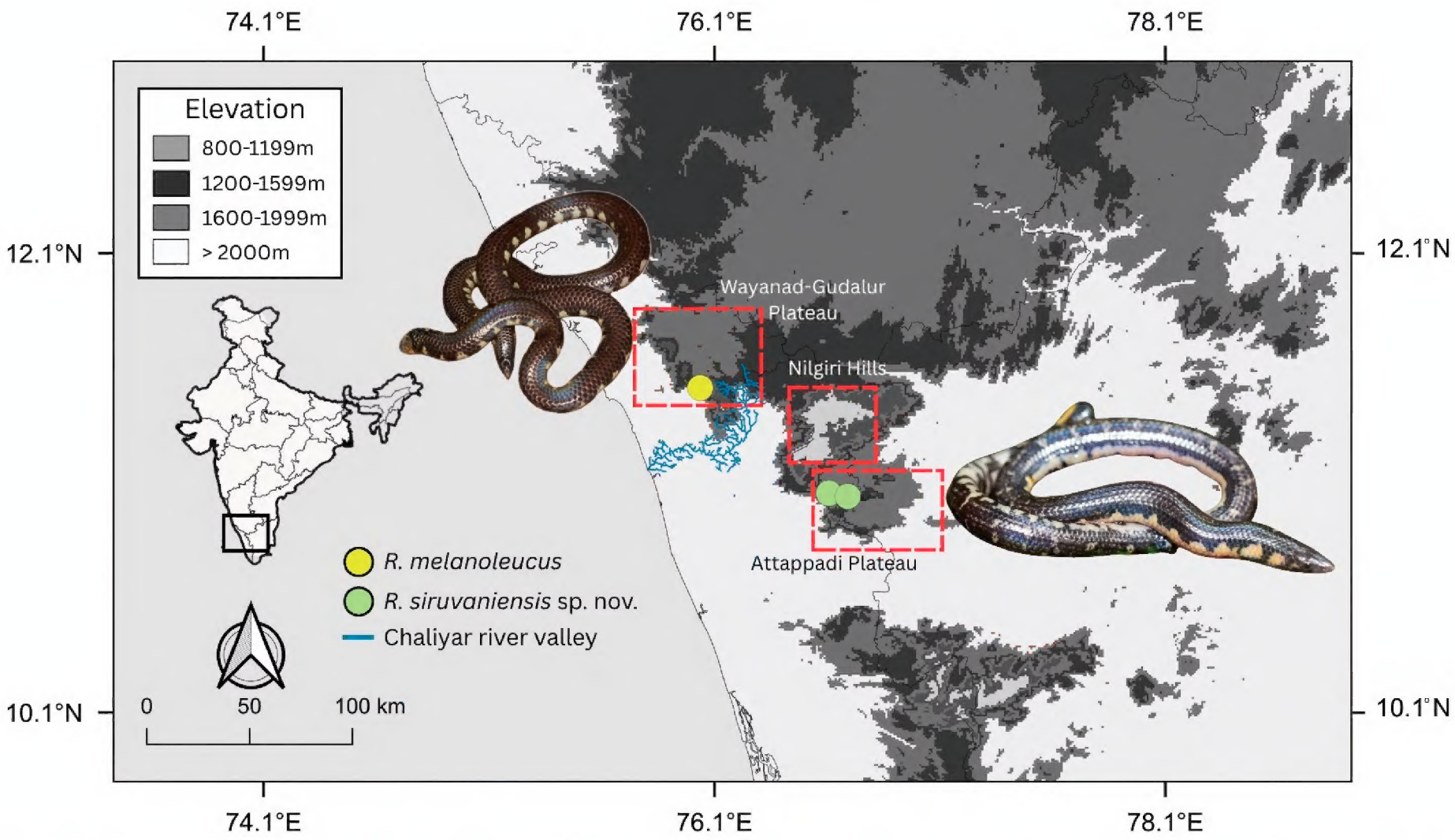

Figure 5. Map of the southern portion of the Central Western Ghats showing the type localities and distribution of *Rhinophis siruvaniensis* sp. nov. and its sister species, *R. melanoleucus*. The Chaliyar River is indicated by blue lines and the Wayanad-Gudalur Plateau, the Nilgiri Massif and the Attappadi Plateau in Siruvani Hills are indicated within red dashed squares.

another specimen of this species (CESS194) which has a ventral count of 191. Although there might be a slight overlap in the ventral scale counts between these two species, our examinations indicate that *R. goweri* have fewer ventral scales (191–200) than *R. siruvaniensis* sp. nov. (202–205 ventral scales). Nevertheless, our phylogenetic analyses indicate that *R. siruvaniensis* sp. nov. is more closely related to other Indian *Rhinophis* than to *R. goweri*, which is presumed to be more closely related to other Sri Lankan *Rhinophis* than to other Indian congeners, albeit with low support.

This is the first and only report of the genus *Rhinophis* in Siruvani Hills—the new species is currently not known to co-occur with any of the known congeners. Most other congeners occurring north of the Palghat gap are restricted to the Wayanad-Gudalur Plateau. The nearby Cherambady of the Gudalur Plateau situated ca. 63 km north of Siruvani Hills is the type locality of *R. sanguineus*. Two more recently described congeners *R. melanoleucus* and *R. karinthandani* occur another 25 km westward from Cherambady, in the Lakkidi, (Cyriac et al. 2020; Sampaio et al. 2020). The only other *Rhinophis* reported from the Attappadi Plateau is *R. fergusonianus*, which is perhaps broadly parapatric with *R. siruvaniensis* sp. nov. This species originally described from the Cardamom Hills, was recently reported from north of the Palghat Gap, including the Attappadi Plateau (Annamooli-Attappadi Rd.), but only at lower elevations (< 150 m asl) (Gower et al. 2023). The presence of four distinct *Rhinophis* species in this one region alone—the Nilgiri-Waynad sensu Wall (1919)— reveals the high diversity of burrowing snakes of this part of the Western Ghats. Despite the historical studies by Beddome (1886) and later Wall (1919) and Roux (1928), the discovery of *R. siruvaniensis* sp. nov. in this region stresses the need for continued biodiversity exploration and documentation.

The Siruvani Hills are also the type locality of a few other recently described narrowly endemic species of herpetofauna. Three rhacophorid frogs, *Raorchestes aureus*, *R. drutaahu* and *R. vellikannan* were recently described from the western windward versant of this massif in Elivaimalai, (Vijayakumar et al. 2014; Garg et al. 2021). Jins et al. (2018) described a new shieldtail snake *Uropeltis bhupathyi* from the eastern rain-shadow area of the Siruvani Hills, in Anaikatti. Two lizards, *Dravidoseps nilgiriensis* and *Hemidactylus easai* are also known from this region (Ganesh et al. 2021; Das et al. 2022). The most-recent addition, the uropeltid *Teretrurus siruvaniensis*, is from very close to the type locality of *Rhinophis siruvaniensis* sp. nov. where it co-occurs with the new species (Cyriac et al. 2024). Because the current known distribution range of *R. siruvaniensis* sp. nov. is entirely outside protected areas or conservation reserves, there is a strong need to conserve the forests at the type locality, which is currently dominated by monoculture plantation.

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Supplementary material 1

List of Indian *Rhinophis* specimens examined

Authors: Vivek Philip Cyriac, P. K. Umesh, N. S. Achyuthan, Vidisha Kulkarni, S. R. Ganesh

Data type: pdf

Explanation note: List of Indian *Rhinophis* specimens examined for the current study Voucher code

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Link: https://doi.org/10.3897/evolsyst.9.150536.suppl

Supplementary material 2

Genbank accession numbers of the sequences used to reconstruct the phylogenetic tree

Authors: Vivek Philip Cyriac, P. K. Umesh, N. S. Achyuthan, Vidisha Kulkarni, S. R. Ganesh

Data type: pdf

Explanation note: GenBank accession numbers for sequences of uropeltids snakes used for the phylogenetic analyses. New sequences generated during this study are indicated in bold. Hyphen (-) indicates lack of data.

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Supplementary material 3

Dorsal scale row reduction formula of the holotype and two paratypes of *Rhinophis siruvaniensis* sp. nov.

Authors: Vivek Philip Cyriac, P. K. Umesh, N. S. Achyuthan, Vidisha Kulkarni, S. R. Ganesh

Data type: pdf

Explanation note: Scale row reduction formula for the three type specimens of *Rhinophis siruvaniensis* sp. nov.

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